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This figure is intended also to show another thing which may be done with the triangles: it was possible, of course, by the instruments themselves, to divide the circle into four, six, eight, and twelve parts, as has been already described. Now, applying the T square to the end of the board, and the 60° triangle to it, as shown at the right in Fig. 127, its hypothenuse (or longest side) makes of course an angle of 60° with the horizontal. Now, applying the 45° triangle to this hypothenuse in its turn, as shown, it is evident that we in effect subtract 45° from 60°—that is to say, that $a\,b$ makes an angle of 15° with the horizontal line $b\,c$, and $e\,d$ the same angle with the vertical line $d\,f$. And if the 60° triangle be placed on its longer side, as at the left, the two short sides of the other one make also angles of 15° with the horizontal and vertical lines respectively, but the inclinations are in the opposite directions as compared with the others, as if $b\,a$ sloped downward to the left from b instead of to the right, and similarly with regard to $e\,d$, which would fall to the right of $d\,f$. By the use, then, of the triangles, separately and together, in connection with the T square, we can lay off mechanically angles of 15°, 30°, 45°, 60°, and 75°, with the horizontal or vertical line, dividing the quadrant into six, or the circle into twenty-four equal parts. It is not pretended that this is always the best way to make such divisions; but still, as the main difficulty lies in drawing the diameters exactly through the centre of the circle, it will effect the object with a sufficient degree of precision for very many practical purposes, and familiarity with all these capabilities of these little general utility contrivances will go a great way in saving labor and time, as we shall see more clearly in the construction of mechanical details.

We give in Fig. 128 an exercise in simple line work, which will in the execution illustrate the advantage of using, as we have suggested above, the triangle for drawing the short vertical lines, which constitute a very large portion of it. The figure represents a panel ornamented with fretwork in the Greek style, the panel being sunken and the fretwork raised, in order to give the full effect of which a portion is shaded, heavy sunlight shadows being also introduced on the extreme left. On the right a portion is left unfinished in order to illustrate the construction, which is extremely simple.

The horizontal dotted lines indicate the construction lines, which are first of all to be drawn lightly in pencil from end to end. The distances between these lines are indicated by the figures in the vertical row at the right, which are the numbers of divisions on any scale of equal parts. Thus in the figure: from 0 to 1 is one eighth of an inch; from 0 to 3, three eighths; to 4, one half; to 6, three quarters, and so on. In other words, we set off from the starting point, or zero, alternately an eighth of an inch and a quarter of an inch, or any other spaces in the proportion of one to two. The longitudinal spacing is precisely the same, as indicated by the figures on the lowest horizontal construction line of the fretwork pattern.

Thus, drawing all the horizontals first, and then marking off these points, as 1, 3, 4, 6, 7, etc., all along the line, and beginning with the triangle at the left-hand side, the verticals are rapidly drawn of precisely the right length in pencil, and may then be inked in at once, the horizontal outlining with the pen next, using the T square, and the whole is ready for shading after erasing the construction lines. These latter should be very fine and lightly drawn, for this is one of the cases in which it would be the height of absurdity to attempt even, by repetition of measurements for each member and parts of members, to stop *every* line in pencil where it is to end in ink; all the verticals may be thus treated, but the horizontals should be drawn through at the outset, at least as far as the fretwork extends, but no farther beyond that limit than necessary to make sure that they do not stop short of it, of which the eye should be able to judge pretty accurately.

The line shading will be found excellent practice, not only in training the hands in the manipulation of the T square and triangle, but in training the eye to judge accurately of spacing; for this is done by merely moving the triangle along the edge of the square, and no spacing dividers will be of any service in getting the distances between the shading lines right, for even if they were accurately pricked off on the paper, the difficulty would be to draw the lines precisely through the points, and the eye which can ensure that can with equal ease and certainty determine the equality of such small spaces without any points to look at. That is, until the eye tires: different individuals are differently endowed by nature in this respect; practice will do much for all, but there are some whom no amount of practice will enable to overcome an inherent uncertainty in the execution of this kind of work, while others can rule the whole surface of a large plan with the precision and almost the speed of machinery. Still, if practice will not in all cases make perfect, according to the proverb, it will do much in that direction, and it is by no means the worst employment for spare moments when they are too few to be advantageously used in other and more important work. By this, however, we do not wish the reader to be misled in regard to one point, which is, that it is not well to shade a surface, in a finished drawing, piecemeal. The eye and hand having once got the *rhythm* of a certain tone in shading, it is best to keep on continuously until the whole of that surface is shaded, if it be possible to do so; there is danger of losing the precise spacing, thickness of line, or in light work (where the use of thinner ink is admissible) the tint, or depth of tone of the lines. And if it be not possible, the precaution should be taken of practising a little on a loose piece of paper, in order to avoid any such discrepancy, before resuming work on the drawing itself.

(To be continued.)

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*The * indicates that the article is illustrated by engravings.*

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The simple fact of which we must not lose sight is, that a right angle measures 90°, whether it be in the triangle or the drawing-board; and if they do not "agree," so much the worse for one or both the implements. They *must* agree; and the draughtsman who appeals to the results of his experience to sustain this line of argument, should patch up the quarrel between his instruments, when he will find that he can draw true lines with a good triangle as well as false inferences from a bad one.

The reason for preferring to use the triangle, in drawing short offset lines perpendicular to the T square, whether the latter happens to be at the time applied to the end or the side of the drawing-board, is that it saves time to do so. The triangle can be put in position much more quickly than the larger square can be raised and turned round. And as will be seen when we come to it, in the drawing of machinery especially, matters so shape themselves that we have a great many short verticals to draw, which will render this saving of time, which for one or two lines would be scarcely appreciable, an item of very considerable consequence. And the saving is the greater, because in using the square in this way it is not necessary to keep the hand upon the stock. Once applied fairly to the board, it is kept in position by pressing on the blade with the thumb and a finger of the left hand, the other fingers being free to assist in the manipulation of the triangle, which, bearing on the upper edge of the blade, is readily pushed up along with the square when it is moved up, and as readily brought into adjustment again when it is moved down, in case new horizontals are to be drawn; besides all which, the dividers, scale, or compasses may conveniently be laid down upon the blade, and moved with it as it slides. They are thus always at hand when wanted, and this at least could not be done if the square were to be changed from side to end and back again every few moments. We insist yet that accuracy and neatness are more important than rapidity in the execution of work of any kind, and more particularly of drawing; but despatch is an important qualification notwithstanding, and all reasonable means should be employed to attain it. Among these means, the "fluent use of the triangles," to which so much space and time have purposely been devoted, is one of the most efficient; and this is just as true, whether they be used by themselves or in company with the T square, as shown in Fig. 127, which represents the 60° triangle in position for drawing the short verticals spoken of. It may be worth while to add that when the short leg of this triangle will answer the purpose of drawing the lines, it is better to use it as shown at the left of the figure, because this selection gives a longer bearing against the T square.

This figure is intended also to show another thing which may be done with the triangles: it was possible, of course, by the instruments themselves, to divide the circle into four, six, eight, and twelve parts, as has been already described. Now, applying the T square to the end of the board, and the 60° triangle to it, as shown at the right in Fig. 127, its hypothenuse (or longest side) makes of course an angle of 60° with the horizontal. Now, applying the 45° triangle to this hypothenuse in its turn, as shown, it is evident that we in effect subtract 45° from 60°—that is to say, that $a\,b$ makes an angle of 15° with the horizontal line $b\,c$, and $e\,d$ the same angle with the vertical line $d\,f$. And if the 60° triangle be placed on its longer side, as at the left, the two short sides of the other one make also angles of 15° with the horizontal and vertical lines respectively, but the inclinations are in the opposite directions as compared with the others, as if $b\,a$ sloped downward to the left from b instead of to the right, and similarly with regard to $e\,d$, which would fall to the right of $d\,f$. By the use, then, of the triangles, separately and together, in connection with the T square, we can lay off mechanically angles of 15°, 30°, 45°, 60°, and 75°, with the horizontal or vertical line, dividing the quadrant into six, or the circle into twenty-four equal parts. It is not pretended that this is always the best way to make such divisions; but still, as the main difficulty lies in drawing the diameters exactly through the centre of the circle, it will effect the object with a sufficient degree of precision for very many practical purposes, and familiarity with all these capabilities of these little general utility contrivances will go a great way in saving labor and time, as we shall see more clearly in the construction of mechanical details.

We give in Fig. 128 an exercise in simple line work, which will in the execution illustrate the advantage of using, as we have suggested above, the triangle for drawing the short vertical lines, which constitute a very large portion of it. The figure represents a panel ornamented with fretwork in the Greek style, the panel being sunken and the fretwork raised, in order to give the full effect of which a portion is shaded, heavy sunlight shadows being also introduced on the extreme left. On the right a portion is left unfinished in order to illustrate the construction, which is extremely simple.

The horizontal dotted lines indicate the construction lines, which are first of all to be drawn lightly in pencil from end to end. The distances between these lines are indicated by the figures in the vertical row at the right, which are the numbers of divisions on any scale of equal parts. Thus in the figure: from 0 to 1 is one eighth of an inch; from 0 to 3, three eighths; to 4, one half; to 6, three quarters, and so on. In other words, we set off from the starting point, or zero, alternately an eighth of an inch and a quarter of an inch, or any other spaces in the proportion of one to two. The longitudinal spacing is precisely the same, as indicated by the figures on the lowest horizontal construction line of the fretwork pattern.

Thus, drawing all the horizontals first, and then marking off these points, as 1, 3, 4, 6, 7, etc., all along the line, and beginning with the triangle at the left-hand side, the verticals are rapidly drawn of precisely the right length in pencil, and may then be inked in at once, the horizontal outlining with the pen next, using the T square, and the whole is ready for shading after erasing the construction lines. These latter should be very fine and lightly drawn, for this is one of the cases in which it would be the height of absurdity to attempt even, by repetition of measurements for each member and parts of members, to stop *every* line in pencil where it is to end in ink; all the verticals may be thus treated, but the horizontals should be drawn through at the outset, at least as far as the fretwork extends, but no farther beyond that limit than necessary to make sure that they do not stop short of it, of which the eye should be able to judge pretty accurately.

The line shading will be found excellent practice, not only in training the hands in the manipulation of the T square and triangle, but in training the eye to judge accurately of spacing; for this is done by merely moving the triangle along the edge of the square, and no spacing dividers will be of any service in getting the distances between the shading lines right, for even if they were accurately pricked off on the paper, the difficulty would be to draw the lines precisely through the points, and the eye which can ensure that can with equal ease and certainty determine the equality of such small spaces without any points to look at. That is, until the eye tires; different individuals are differently endowed by nature in this respect; practice will do much for all, but there are some whom no amount of practice will enable to overcome an inherent uncertainty in the execution of this kind of work, while others can rule the whole surface of a large plan with the precision and almost the speed of machinery. Still, if practice will not in all cases make perfect, according to the proverb, it will do much in that direction, and it is by no means the worst employment for spare moments when they are too few to be advantageously used in other and more important work. By this, however, we do not wish the reader to be misled in regard to one point, which is, that it is not well to shade a surface, in a finished drawing, piecemeal. The eye and hand having once got the *rhythm* of a certain tone in shading, it is best to keep on continuously until the whole of that surface is shaded, if it be possible to do so; there is danger of losing the precise spacing, thickness of line, or in light work (where the use of thinner ink is admissible) the tint, or depth of tone of the lines. And if it be not possible, the precaution should be taken of practising a little on a loose piece of paper, in order to avoid any such discrepancy, before resuming work on the drawing itself.

(To be continued.)

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*The * indicates that the article is illustrated by engravings.*

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